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BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Application Number: 10/720,492
Filing Date: November 24, 2003
Appellants: FULGHUM ET AL.

Jennifer K. Stewart
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 6/18/2008 appealing from the Office action

mailed 11/23/2007.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

No amendment after final has been filed.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is

correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

US 2001/0053177 ,   PAPASAKELLARIOU   ,   12-2001

5,754,583   EBERHARDT ET AL   5/1998

(9) Grounds of Rejection

The following grounds of rejection are applicable to the appealed claims:

I.   Claims 1, 4, 5, 12, 16, 20, 21, 28, 31-35, 40, 44-52, 58, 62-68, 71, 74-79,

81-85, 87 and 89 are rejected under 35 U.S.C. 102(b) as being anticipated by

Papasakellariou (US 2001/0053177).

II.   Claims 2, 6, 8, 9, 11, 13, 15, 17, 19, 22-27, 29, 30, 36-39, 41-43, 53-57,

59-61, 69, 70, 72, 73, 80, 86 and 88 are rejected under 35 U.S.C. 103(a) as being

unpatentable over Papasakellariou (US 2001/0053177) in view of Eberhardt et al (US

5,754,583).

The rejections are hereby reproduced for convenience.

I.   Claims 1, 4, 5, 12, 16, 20, 21, 28, 31-35, 40, 44-52, 58, 62-68, 71, 74-79, 81-85,

87 and 89 are rejected under 35 U.S.C. 102(b) as being anticipated by Papasakellariou

(US 2001/0053177).

Regarding claims 1, 5, 12, 16, 20, 32-35, 40, 44-46, 48-51, 58, 77, 78, 83, 84 and

89, Papasakellariou discloses a spread spectrum receiver with correlating coprocessor

having code cross-correlations for efficient interference cancellation (abstract). The

correlation coprocessors are used for code search and despreading in rake reception

(paragraph 0020). The interference effect after despreading is proportional to the code

cross-correlations of the interfering and desired signals. For non-zero cross-

correlations, the interfering signals have a non-zero effect on the decision statistics of

the desired signals. The contribution of each interferer on the decision statistic of the

desired signal can be removed if in addition to the previous information, the code cross-

correlations are computed (paragraph 0009). The code cross-correlations are multiplied

by each interfering signal's complex amplitude and information symbol. The result is

subtracted from the output of the despreader for the desired signal (paragraph 0009).

Regarding claim 4, the vector datapath operates on a set of N chips in parallel (paragraph 0020).

Regarding claims 21, 28, 31, 67, 68, 71 and 74-76, Papasakellariou discloses a spread spectrum receiver with correlating coprocessor having code cross-correlations for efficient interference cancellation (abstract). The correlation coprocessors are used for code search and despreading in rake reception (paragraph 0020). The interference effect after despreading is proportional to the code cross-correlations of the interfering and desired signals. For non-zero cross-correlations, the interfering signals have a non-zero effect on the decision statistics of the desired signals. The contribution of each interferer on the decision statistic of the desired signal can be removed if in addition to the previous information, the code cross-correlations are computed (paragraph 0009). The code cross-correlations are multiplied by each interfering signal's complex amplitude and information symbol (paragraph 0009). Therefore, the code cross-correlation is weighted by the interfering signal's complex amplitude. The result is subtracted from the output of the despreader for the desired signal (paragraph 0009).

Regarding claims 47, 52, 62-66, 79, 81, 82, 85 and 87, Papasakellariou discloses the code cross-correlations are multiplied by each interfering signal's complex amplitude and information symbol (paragraph 0009). Therefore, the code cross-correlation is weighted by the interfering signal's complex amplitude. The result is subtracted from the output of the despreader for the desired signal (paragraph 0009).

II.   Claims 2, 6, 8, 9, 11, 13, 15, 17, 19, 22-27, 29, 30, 36-39, 41-43, 53-57, 59-61, 69, 70, 72, 73, 80, 86 and 88 are rejected under 35 U.S.C. 103(a) as being

unpatentable over Papasakellariou (US 2001/0053177) in view of Eberhardt et al (US 5,754,583).

Regarding claims 2, 6, 13, 17, 22, 29 and 53, Papasakellariou discloses the receiver and method of using the receiver as stated above. Papasakellariou does not disclose the rake receiver generates estimated channel coefficients. Eberhardt discloses a rake finger generates a weighted channel estimate (column 10, lines 43-63). The channel estimate improves performance of the receiver by reassigning the fingers to more accurately recover the transmitted signal (column 10, line 64 to column 11, line 21) in a communication system where fading occurs. For this reason, it would have been obvious for one of ordinary skill in the art at the time of the invention to combine the teachings of Eberhardt into the receiver and method of using the receiver of Papasakellariou.

Regarding claims 8, 24 and 25, Papasakellariou discloses a spread spectrum receiver with correlating coprocessor having code cross-correlations for efficient interference cancellation (abstract). The correlation coprocessors are used for code search and despreading in rake reception (paragraph 0020). The interference effect after despreading is proportional to the code cross-correlations of the interfering and desired signals. For non-zero cross-correlations, the interfering signals have a non-zero effect on the decision statistics of the desired signals. The contribution of each interferer on the decision statistic of the desired signal can be removed if in addition to the previous information, the code cross-correlations are computed (paragraph 0009). The code cross-correlations are multiplied by each interfering signal's complex amplitude

and information symbol (paragraph 0009). Therefore, the code cross-correlation is weighted by the interfering signal's complex amplitude. The result is subtracted from the output of the despreader for the desired signal (paragraph 0009). Papasakellariou does not disclose the rake receiver comprising a multi-channel filter to reduce intersymbol interference. Eberhardt discloses a finite impulse response (FIR) filter 200 for the use in the mobile station 100 for providing low pass filtering (column 8, lines 36-42). The filter 200 uses a number of delay elements, multipliers and a summer to output the filtered signal. Filter 200 is found in each finger (figure 1). It would have been obvious for one of ordinary skill in the art at the time of the invention to utilize the filter of Eberhardt in the receiver and method of using the receiver of Papasakellariou. The filter will allow unwanted components of the received signal to be removed and will allow the originally transmitted signal to be recovered correctly.

Regarding claims 9 and 26, Papasakellariou does not disclose the rake receiver generates estimated channel coefficients. Eberhardt discloses a rake finger generates a weighted channel estimate (column 10, lines 43-63). The channel estimate improves performance of the receiver by reassigning the fingers to more accurately recover the transmitted signal (column 10, line 64 to column 11, line 21) in a communication system where fading occurs. For this reason, it would have been obvious for one of ordinary skill in the art at the time of the invention to combine the teachings of Eberhardt into the receiver and method of using the receiver of Papasakellariou.

Regarding claims 11 and 27, figure 2 of Eberhardt discloses the filter.

Regarding claims 15, 19, 23, 30, 36-39, 41-43, 54-57, 59-61, 69, 70, 72, 73, 80, 86 and 88, Papasakellariou discloses the receiver and method of using the receiver as stated above. Papasakellariou does not disclose the rake receiver comprising a multi-channel filter to reduce intersymbol interference. Eberhardt discloses a finite impulse response (FIR) filter 200 for the use in the mobile station 100 for providing low pass filtering (column 8, lines 36-42). The filter 200 uses a number of delay elements, multipliers and a summer to output the filtered signal shown in figure 2. Filter 200 is found in each finger (figure 1). It would have been obvious for one of ordinary skill in the art at the time of the invention to utilize the filter of Eberhardt in the receiver and method of using the receiver of Papasakellariou. The filter will allow unwanted components of the received signal to be removed and will allow the originally transmitted signal to be recovered correctly.

(10) Response to Argument

(A) Introduction

Prior to responding to the arguments, the examiner would like to describe the field of invention which is the same for the application and the Papasakellariou reference.

In code division multiple access (CDMA) spread spectrum signals, many simultaneous users are transmitted in each transmission. Pseudo-random spreading codes spread each of the individual users and in the receiver, each user signal is despread with the same pseudo-random spreading code associated with each individual user signal. The receiver is a RAKE receiver. In a RAKE receiver, each of the RAKE fingers is used to recover a user in the spread system. Each finger will be associated with the unique spreading code. The RAKE receiver receives the transmitted signal and the signal branches into a plurality of fingers. Each branch is despread with a spreading code, which will recover a separate user in each finger by separating the desired user associated with the spreading code for a finger from the user signals that are associated with the other RAKE fingers. Therefore, since each RAKE finger recovers a specific user signal, the other user signals present in the first finger, will interfere with the first specific user signal. The same will be true in the second and subsequent fingers.

(B) Papasakellariou reference

Papasakellariou discloses a spread spectrum receiver that recovers transmitted user signals in a CDMA system. Paragraph 0003 provides additional background information regarding CDMA systems. The receiver utilizes rake reception (paragraph 0020) and interference is removed from the received signals after despreading. The contribution of each interferer on the desired signal can be removed if

the code cross-correlations are computed (paragraph 0009). The cross-correlations are

simply multiplied by each interfering signal and information symbol. The result is

subtracted from the output of the despreader to generate the desired signal (paragraph

0009).

(C) Response to arguments

The examiner discusses the claims in the same order as appellant.

1.   Claim 32

For clarification, the elements of claim 32 have been matched with the

equivalent Papasakellariou elements (**in bold**) below:

A RAKE receiver (**paragraph 0020 discloses the co-processors are used in rake**

reception) comprising:

a plurality of RAKE fingers to despread unknown symbols received over multiple paths

of a multi-channel (**as recited in the background above, a RAKE receiver inherently**

comprises rake fingers to allow the multiple users in the multiple access system

to be recovered in the receiver, despreading of the signals is described in

paragraph 0003);

a processor to determine a cross-correlation between the different symbols based on a

code cross-correlation between the spreading codes for the different symbols

(paragraph 0007 discloses computing the code cross-correlation and performing

interference cancellation and paragraph 0009 discloses this cross-correlation in

more detail. The interference effect after despreading is proportional to the cross-

correlation of the interfering and desired signals); and

a combiner to combine the symbol of interest with the interfering symbol using weighting

factors determined based on the cross-correlation between the different symbols to

generate an estimate of the symbol of interest with reduced interference (**paragraph**

0009 discloses the code cross-correlation of the interfering and desired signals,

are computed and the cross-correlations are simply multiplied by each interfering

signals complex amplitude and information symbol. The result, of this

multiplication, is subtracted from the output of the despreader for the desired

signal. In addition, appellant acknowledges Papasakellariou determines the

interfering signals and uses the code cross-correlation to weight the determined

interfering symbols in page 11 of the appeal brief).

The term "unknown" symbol is not explicitly defined in the claims. The term unknown

symbols was added to the claims in an amendment filed on 6/29/2007. In the remarks

presented with the amendment, applicant distinguished between the known pilot

symbols of the reference and the unknown symbols of the transmission. For examination purposes, the unknown symbols were treated as symbols that were not known at the receiver prior to the reception of the symbols. When pilot symbols are transmitted, these symbols are known both at the transmitter and the receiver. They have advantages since the receiver can determine the effect of a channel or other distortion on the transmission since the data in the transmission is known to the receiver prior to the actual reception of the symbols. Any change between the received symbols and the symbols known in the receiver would be attributed to the channel distortion. The pilot values will be stored somewhere at the receiver prior to the reception of the pilot symbols. In Papasakellariou, the receiver does not receive pilot symbols. The transmissions comprise user data and the receiver does not have prior knowledge of what data is being transmitted. If the receiver already knew what data was to be transmitted, there would be no need to actually send the data. For this reason, the interfering symbols and the symbol of interest are unknown symbols.

Appellant states though Papasakellariou uses code cross-correlations as part of an interference reduction process, Papasakellariou does not use code cross-correlations as part of a despread symbol or RAKE combining process. The examiner disagrees since the reference discloses the system is a RAKE receiver (paragraph 0020) and the combining described above weights the determined interfering symbols in the RAKE receiver. Appellant acknowledges Papasakellariou determines the interfering signals and uses the code cross-correlation to weight the determined interfering symbols in page 11 of the appeal brief.

2.   Claims 1, 5, 49, 67, 77 and 83

Appellant states each of the independent claims 1, 5, 47, 67, 77 and 83 explicitly require processing unknown symbols to reduce interference and combining the despread symbols based on code cross-correlations. These arguments are identical to the arguments provided with respect to independent claim 32. Therefore, the response to these arguments is the same as recited in the response to arguments regarding claim 32 recited above.

3.   Claims 16 and 21

For clarification, the elements of claim 16 have been matched with the equivalent Papasakellariou elements (**in bold**) below:

A RAKE receiver comprising:

a plurality of RAKE fingers to despread unknown symbols received over multiple paths of a multi-channel (**as recited in the background above, a RAKE receiver inherently comprises rake fingers to allow the multiple users in the multiple access system to be recovered in the receiver, despreading of the signals is described in paragraph 0003**);

a processor to determine a cross-correlation between the symbol of interest and the

interfering symbol based on a code cross-correlation between the spreading codes for

the symbol of interest and the interfering symbol (**paragraph 0007 discloses**

computing the code cross-correlation and performing interference cancellation

and paragraph 0009 discloses this cross-correlation in more detail. The

interference effect after despreading is proportional to the cross-correlation of

the interfering and desired signals); and

a combiner to combine the symbol of interest with the interfering symbol using the

cross-correlation to reduce intersymbol interference attributable to the interfering symbol

from the symbol of interest (**paragraph 0009 discloses the code cross-correlation ,**

of the interfering and desired signals, are computed and the cross-correlations

are simply multiplied by each interfering signals complex amplitude and

information symbol. The result, of this multiplication, is subtracted from the

output of the despreader for the desired signal).

a second combiner to combine successive RAKE output symbols produced over a

plurality of successive symbol periods using weighting factors determined based on the

cross correlations between the symbols to reduce intersymbol interference attributable

to the at least one interfering symbol from the symbol of interest (**Multiple iterations of**

the interference canceller are used (paragraph 0081) Therefore, multiple symbol

periods are used. These multiple iterations allow the removed components to be

accumulated and removed from the received signal in it's entirely. In other words,

each iteration of the interference canceller acts as a separate combiner and

several iterations are necessary to accurately estimate the symbol of interest.

Appellant acknowledges Papasakellariou determines the interfering signals and

uses the code cross-correlation to weight the determined interfering symbols on

page 11 of the appeal brief).

Applicant states the code correlations are used before the RAKE combining.
However, the combining takes place in the RAKE receiver and the combining is the
RAKE combining. The subtraction recited above combines the symbols. Applicant
states the rejection does not address the second combiner. However, Papasakellariou
discloses multiple iterations of the interference canceller are used (paragraph 0081)
Therefore, multiple symbol periods are used since each iteration will take place over a
different symbol period than the previous iteration. These multiple iterations allow the
removed components to be accumulated and removed from the received signal in it's
entirely. In other words, each iteration of the interference canceller acts as a separate
combiner and several iterations are necessary to accurately estimate the symbol of
interest

4.   Claim 12

Appellant states claim 12 explicitly require processing unknown symbols to reduce interference and combining the despread symbols based on code cross-correlations. These arguments are identical to the arguments provided with respect to independent claim 32. Therefore, the response to these arguments is the same as recited in the response to arguments regarding claim 32 recited above. In addition, appellant states claim 12 requires combining filtered output symbols (the previously combined despread symbols) to further reduce interference in the symbol of interest. However, Papasakellariou discloses combining the despread symbols as stated in the previous argument and recited in paragraph 0009 (The interference can be cancelled after despreading; the result is subsequently subtracted from the output of the despreader for the desired signal). The combining generates a plurality of filter output symbols. Appellant defines the filtered outputs symbols as the previously combined despread symbols as indicated by appellant on page 12 of the brief. Since this combination will remove unwanted component and generate the desired signal as described above, it will generated filtered outputs. Appellant states Papasakellariou fails to teach a second combining limitation. However, Papasakellariou discloses multiple iterations of the interference canceller are used (paragraph 0081) Therefore, multiple symbol periods are used since each iteration will take place over a different symbol period than the previous iteration. These multiple iterations allow the removed components to be accumulated and removed from the received signal in it's entirely. In other words, each iteration of the interference canceller acts as a separate combiner and several iterations are necessary to accurately estimate the symbol of interest

    5.   Claim 28

Appellant states claim 28 explicitly require processing unknown symbols to reduce interference. This arguments are identical to the arguments provided with respect to independent claim 32. Therefore, the response to these arguments is the same as recited in the response to arguments regarding claim 32 recited above. Appellant states independent claim 28 requires combining RAKE output symbols over a plurality of symbol periods using weighting factors determined based on the cross-correlation of different symbols. However, Papasakellariou discloses multiple iterations of the interference canceller are used (paragraph 0081) Therefore, multiple symbol periods are used since each iteration will take place over a different symbol period than the previous iteration. These multiple iterations allow the removed components to be accumulated and removed from the received signal in its entirely. In other words, each iteration of the interference canceller acts as a separate combiner and several iterations are necessary to accurately estimate the symbol of interest. Appellant indicates Papasakellariou determines the interfering signals and uses the code cross-correlations to weight the determined interfering symbols as stated on page 11 of the appeal brief.

    6.   Claims 4, 20, 31, 33-35, 40, 44-48, 50-52, 58, 62-66, 68, 71, 74-76, 78, 79, 81, 82, 84, 85, 87 and 89.

Appellant does not argue the individual limitations of dependent claims 4, 20, 31,

33-35, 40, 44-48, 50-52, 58, 62-66, 68, 71, 74-76, 78, 79, 81, 82, 84, 85, 87 and 89.

Therefore, the response to arguments of claims 4, 20, 31, 33-35, 40, 44-48, 50-52, 58,

62-66, 68, 71, 74-76, 78, 79, 81, 82, 84, 85, 87 and 89 is the same as the response to

arguments of independent claims 1, 5, 8, 12, 16, 21, 24, 28, 32, 49, 67, 77 and 83

stated above.

7.   Claims 45-48, 63-66, 81, 82 and 87

Appellant states dependent claims 45 and 63 claim ways to reduce weighting

factor computations when the weighting factors are computed using a correlation matrix.

However, claim 45 recites "the correlation matrix of a first symbol period reuses a sub-

matrix of the correlation matrix of a previous symbol period." As stated previously,

Papasakellariou discloses the correlation of the desired signal and the interfering

signals in paragraph 009. The cross correlation between different symbols forms a

correlation matrix and this correlation is reuses in each of the iterations to yield a

corrected desired signal. By refining the desired signal in each iteration, a more

accurate desired signal can be produced and these multiple iterations allow the

removed components to be accumulated and removed from the received signal in its

entirely.

Appellant states dependent claims 46-48 and 64-66 claim multiplying the

combined despread symbols by a scaling factor to improve reliability of the symbol of

interest where the scaling factor may be determined based on the weighting factors. However, Papasakellariou discloses determines the interfering signals and uses the code cross-correlations to weight the determined interfering symbols as indicated by appellant on page 11 of the appeal brief. This weighted interference signal is then subtracted to produce the desired signal (paragraph 0009). This weighting factor is the scaling factor. The weighting factor is inherently based on the weighting factor and is used to improve the reliability and accuracy of the desired symbol of interest as stated above.

Appellant states dependent claims 81, 82 and 87 recite combining successive RAKE output symbols using weighting factors determined based on cross-correlations between different symbols, where the cross-correlations are determined based on code cross-correlations between spreading codes for the different symbols. The examiner disagrees. As stated above, the desired signal and the interfering signals in a RAKE receiver are both user signals and each user signal is spread with unique spreading code. Papasakellariou discloses determining the cross-correlations of the interfering signal and the desired signal (paragraph 0009). Papasakellariou also discloses multiple iterations of the interference canceller are used (paragraph 0081) Therefore, multiple symbol periods are used since each iteration will take place over a different symbol period than the previous iteration. These multiple iterations allow the removed components to be accumulated and removed from the received signal in its entirely. In other words, each iteration of the interference canceller acts as a separate combiner and several iterations are necessary to accurately estimate the symbol of interest.

  8.   Claims 8 and 24

    Appellant states claims 8 and 24 explicitly require processing unknown symbols

to reduce interference and combining the despread symbols based on code cross-

correlations. These arguments are identical to the arguments provided with respect to

independent claim 32. Therefore, the response to these arguments is the same as

recited in the response to arguments regarding claim 32 recited above. In addition,

appellant states claims 8 and 24 require combining filtered output symbols (the

previously combined despread symbols) to further reduce interference in the symbol of

interest. However, Papasakellariou discloses combining the despread symbols as

stated in the previous argument and recited in paragraph 0009 (The interference can be

cancelled after despreading; the result is subsequently subtracted from the output of the

despreader for the desired signal). The combining generates a plurality of filter output

symbols. Appellant defines the filtered outputs symbols as the previously combined

despread symbols as indicated by appellant on page 12 of the brief. Since this

combination will remove unwanted component and generate the desired signal as

described above, it will generated filtered outputs. Appellant states Papasakellariou fails

to teach a second combining limitation. However, Papasakellariou discloses multiple

iterations of the interference canceller are used (paragraph 0081) Therefore, multiple

symbol periods are used since each iteration will take place over a different symbol

period than the previous iteration. These multiple iterations allow the removed

components to be accumulated and removed from the received signal in it's entirely. In

other words, each iteration of the interference canceller acts as a separate combiner

and several iterations are necessary to accurately estimate the symbol of interest

9.   Claims 2, 6, 9, 11, 13, 15, 17, 19, 22, 23, 25-27, 29, 30, 36-39, 41-43, 53-
57, 59-61, 69, 70, 72, 73, 80, 86 and 88.

Appellant does not argue the individual limitations of dependent claims 2, 6, 9,

11, 13, 15, 17, 19, 22, 23, 25-27, 29, 30, 36-39, 41-43, 53-57, 59-61, 69, 70, 72, 73, 80,

86 and 88. Therefore, the response to arguments of claims 2, 6, 9, 11, 13, 15, 17, 19,

22, 23, 25-27, 29, 30, 36-39, 41-43, 53-57, 59-61, 69, 70, 72, 73, 80, 86 and 88 is the

same as the response to arguments of independent claims 1, 5, 8, 12, 16, 21, 24, 28,

32, 49, 67, 77 and 83 stated above.

10. Claims 36-39, 41-43, 54-57, 59-61, 69, 40, 72 and 88

Appellant states claims 36-39, 41-43, 54-57, 59-61, 69, 70, 72, 73 and 88 claim a

second combining step after despreading combining that combines filtered output

symbols and/or RAKE combined output symbols. However, Papasakellariou discloses

multiple iterations of the interference canceller are used (paragraph 0081) Therefore,

multiple symbol periods are used since each iteration will take place over a different

symbol period than the previous iteration. These multiple iterations allow the removed

components to be accumulated and removed from the received signal in it's entirely. In

other words, each iteration of the interference canceller acts as a separate combiner

and several iterations are necessary to accurately estimate the symbol of interest

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the

Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

/Kevin M. Burd/

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